

Charm, B, and QCD Physics in CDF

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for the CDF Collaboration

Fermilab Wine and Cheese Seminar
March 28th, 2003

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Outline

•Introduction

•QCD Physics

- Inclusive Jet cross section
- Dijet mass distribution
- Jet shape and energy flow
- Diffractive dijet production

•Charm Physics

- J/ψ production cross section
- Charm cross section
- Mass: D_s and D^*
- Cabbibo suppressed D^0 decay
- Rare Decay: $D^0 \rightarrow \mu\mu$

•Bottom Physics

- Lifetime: $B^0, B^+, B_s \rightarrow J/\psi X$
- Semileptonic B decays
- Two body $B \rightarrow hh$ decays
- Study of hadronic B decays

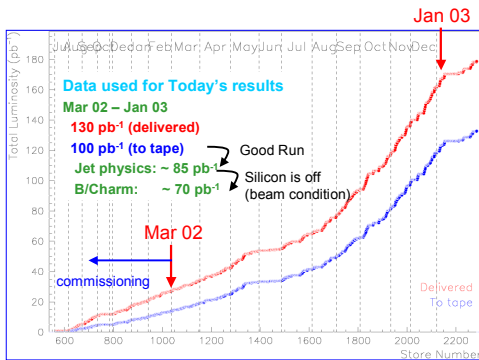
•Summary

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Integrated Luminosity

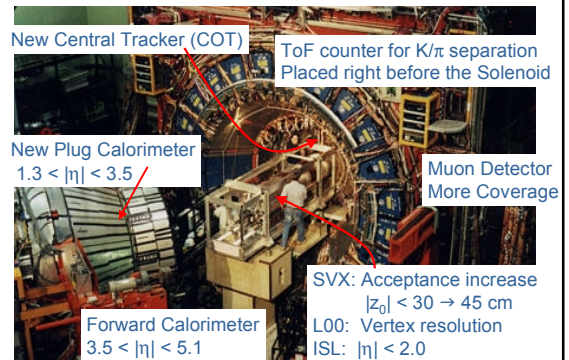


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CDF Detector Overview



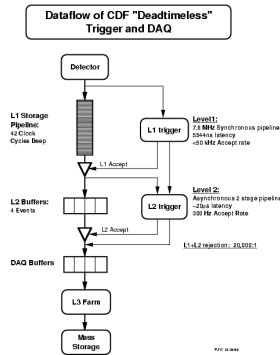
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CDF Trigger System Overview

- Crossing: 396 ns: 2.5 MHz
- Level 1: hardware
 - Calorimeter, Muon, Track
 - 15kHz (reduction $\sim x200$)
- Level 2: hardware + CPU
 - Cal cluster, Silicon track
 - 300 Hz (reduction $\sim x5$)
- Level 3: Linux PC farm
 - Offline quantities
 - 50 Hz (reduction $\sim x6$)



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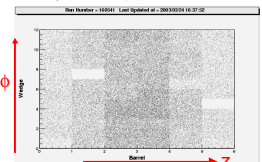
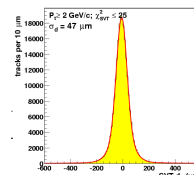
Silicon Vertex Trigger (SVT)

•Level 2: Silicon Vertex Trigger

- Use silicon detector information
- Good IP resolution
- Trigger on displaced track
- beamline reconstruction
- update every ~ 30 seconds
- IP resolution: $\sim 50 \mu m$
- $35 \mu m$ beam size + $35 \mu m$ SVT

•Increase physics sensitivity of the Run II CDF

- CDF as "Charm Factory"
- Millions of D's per 100 pb^{-1}
- Collect Hadronic B sample
- No Lepton required in final state
- B_s physics (mixing in $D_s \pi$)
- Higgs/new particles decaying heavy (b and c) quarks



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QCD Physics Program in CDF

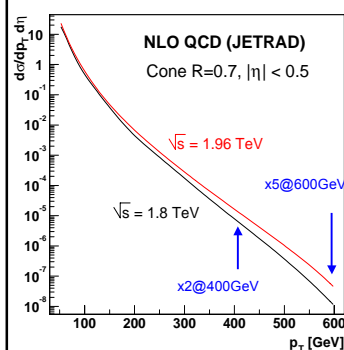
- Jet production
 - Inclusive Jet → Today
 - Dijet → Today
 - > 2 Jet
 - Photon production
 - b-Jet production
 - W/Z + Jet production
 - Background for Top, Higgs..
 - Underlying events → Today
 - Jet Property
 - Jet shape → Today
 - Jet substructure
 - Jet clustering algorithm
 - Diffractive processes → Today
 - And many more....
- Tevatron is a Hadron Collider
- All interactions are fundamentally QCD!
- Understanding the QCD physics is indispensable for many analysis
- Parton distribution function
 - Underlying event
 - QCD process as background

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Inclusive Jet Cross Section



Run I → Run II
1.8 TeV → 1.96 TeV

Theory predicts
x2 higher cross section
at Jet $E_T = 400 \text{ GeV}$

x5 higher cross section
at Jet $E_T = 600 \text{ GeV}$

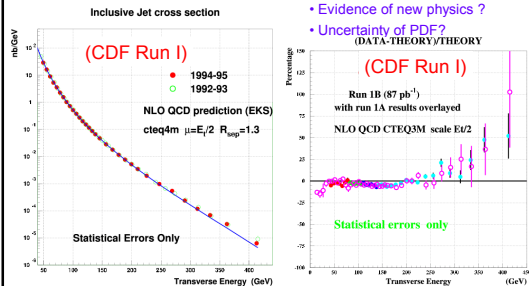
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Inclusive Jet Cross Section (Run I)

- Run I measurement
 - Central Jet: $0.1 < |\eta| < 0.7$
 - Run IA and IB agree well
- Compared with theory prediction
 - NLO QCD + CTEQ3M
 - Excess at high energy
 - Evidence of new physics ?
 - Uncertainty of PDF?



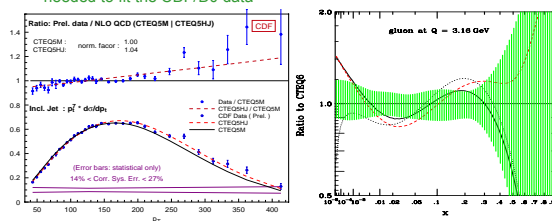
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Fits to the Run I CDF/D0 Data

- The excess can be explained by enhancing the gluon PDF
- Include the CDF/D0 Jet cross section for fitting the PDF
 - Extra weight for high E_T is needed to fit the CDF/D0 data
- Still have large uncertainty for high x gluons
 - Good precision measurement of high E_T Jet cross section may reduce the uncertainty

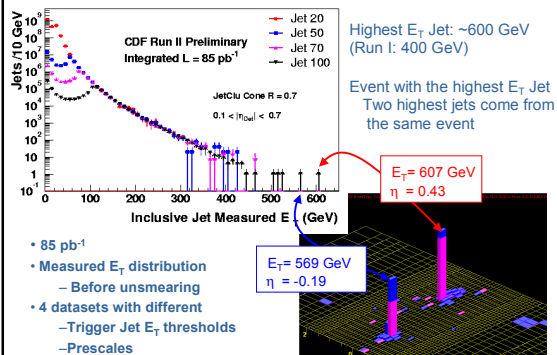


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The Run II Jet E_T distribution



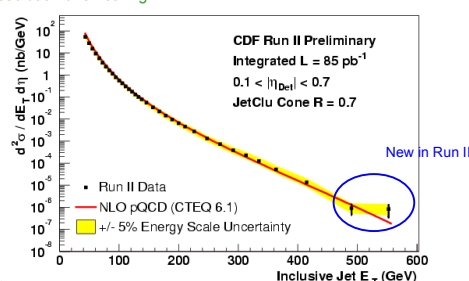
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Inclusive Jet Cross section

- Jet Cross section can be compared with theory after
 - Calorimeter energy correction
 - Resolution unsmearing
- ~ 10 orders of magnitude
- Two high E_T data points
 - Run I: $E_T < 400 \text{ GeV}$



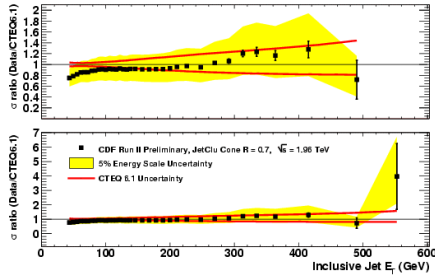
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Comparison with Theory Prediction

- NLO QCD (CTEQ 6.1)
 - Data and Theory agree within error
- The dominant systematic uncertainty
 - Jet energy scale (5%)

CDF Run II Preliminary

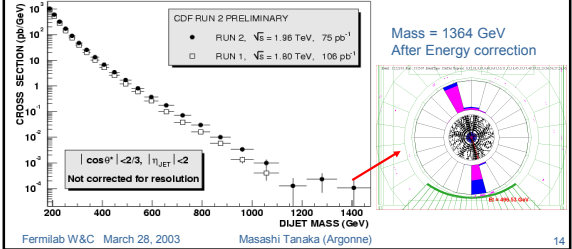


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Dijet Mass Distribution

- Theory predicts Run II dijet cross section is x10 higher than Run I at Mass = 1.4 TeV
- One candidate with $M \sim 1.4$ TeV
 - The same event as the highest E_T jet event
- The distribution is not corrected for calorimeter resolution
- A good place for new physics search (last week's seminar by Eva. H). No evidence of NP.

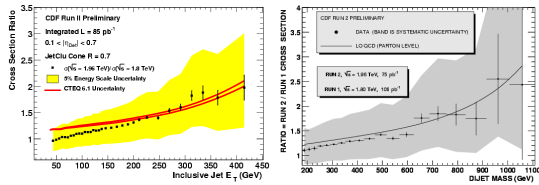


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Run II / Run I Cross Section Ratio

- Inclusive Jet cross section
- Dijet mass distribution



- Theory predicts the Run II/Run I ratio with small uncertainty (~10%)
- Data agrees with theory within error

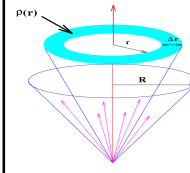
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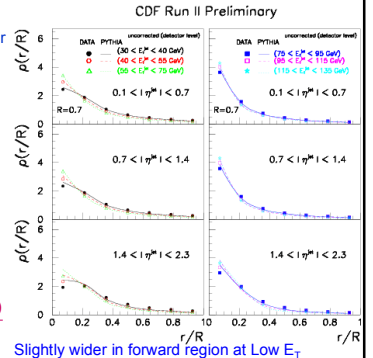
Study of Jet Shapes

Good agreement in Central detector

- Measure differential Jet Shape in the Calorimeter
- Compare with Pythia + detector simulation



$$\rho(r) = \frac{1}{\Delta R_{\text{jet}}} \frac{1}{\sum E_T(r \pm \Delta r/2)} \sum E_T(0, R)$$



Slightly wider in forward region at Low E_T

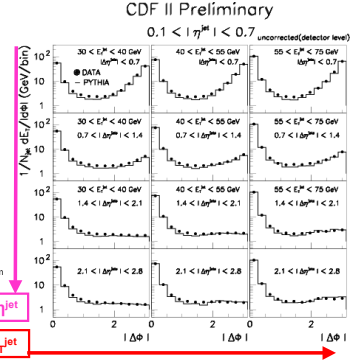
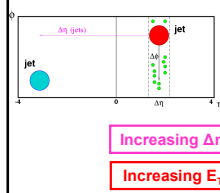
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Study of Energy Flows

- Measure the energy flow with the calorimeter
 - Energy outside of Jet
 - Probe the underlying event
- Compare with Pythia (tuned by using the CDF minimum bias event)

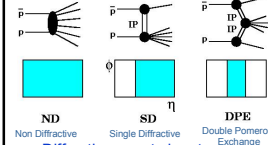


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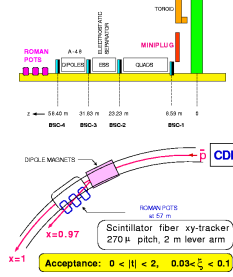
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Diffraction Dijet Production

- Diffraction Process



- Diffraction event signature:
 - No energy deposition in the forward detector
 - Miniplug Calorimeter (MP)
 - Beam Shower Counter (BSC)
 - Directly detect the anti-proton from the diffractive process
 - Roman Pot (RP)



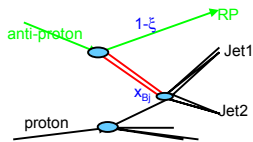
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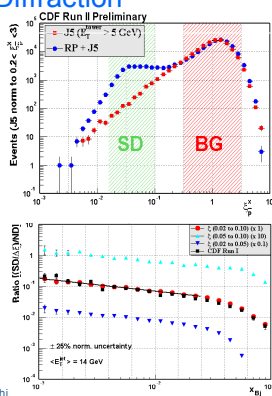
Single Diffraction

- Hits in the Roman Pot
 - anti-proton: diffraction
- ξ : fraction of momentum loss of anti-proton
 - Measured with calorimeter
- x_{Bj} : fraction of anti-proton momentum carried by hard scattering parton



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Double Pomeron Exchange

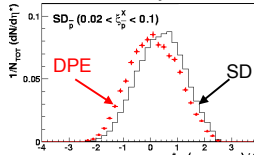
- Dedicated trigger for DPE:
 - No significant energy in east side Miniplug and Beam shower counter
 - Proton: diffraction
 - Hits in the Roman pot detector
 - Anti-proton: diffraction
 - Two low E_T jets

- Collect ~ 15K of DPE candidate events (~100 events in Run I)
- Compare several kinematic quantities between SD and DPE
 - Average η of two jets
 - opening angle of two jets

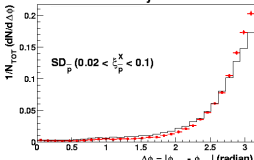
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CDF Run II Preliminary



CDF Run II Preliminary



Bottom and Charm Physics in CDF

- Studies of QCD
 - Onium Production (ψ, Y)
 - Cross section
 - Polarization
 - Charm production
 - Cross section
 - D^{**} Production
 - Bottom Production
 - B Cross section
 - Fragmentation

- Mass and Lifetime
 - $D^0, D^+, D_s, \Lambda_c, \dots$
 - $B^0, B^+, B_s, \Lambda_b, B_c, \dots$

- Rare Decays
 - $B \rightarrow \ell\ell, \ell\ell K, \dots$
 - $D \rightarrow \ell\ell, \ell\ell\pi, \dots$

- Studies of CKM mechanism

- Mixing
 - $D^0, D^+ \rightarrow D^0 \pi, B^0 \rightarrow \ell \nu D, B^0 (|V_{ub}|): B^0 \rightarrow J/\psi K^0, B^0 \rightarrow \ell \nu D$
 - $B_s (|V_{ub}|): B_s \rightarrow D_s \pi, \ell \nu D_s, \dots$
- $\Delta\Gamma_s: B_s \rightarrow J/\psi \phi, J/\psi \eta, \ell \nu D_s, D_s D_s$
- CP violation
 - $\beta: B^0 \rightarrow J/\psi K^0$
 - $\alpha: B^0 \rightarrow \pi\pi$
 - $\gamma: B \rightarrow DK, B_s \rightarrow D_s K$
 - $\gamma: B^0, B_s \rightarrow K\pi, \pi\pi, KK$
 - Exotic: $B_s \rightarrow J/\psi \phi, D^0 \rightarrow KK, \pi\pi$

Study of B_s, Λ_b, B_c
Is unique at
hadron collider

Today's Topics:
Many of the analyses are still
in progress and we show only
status and prospects

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CDF Trigger for B/Charm Physics

- CDF has three dedicated triggers for B/Charm physics

- (1) Dimuon

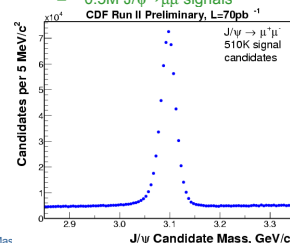
- $J/\psi \rightarrow \mu\mu$

- (2) Lepton + track
- Semileptonic decays

- (3) Two track

- Hadronic decays

- (1) Dimuon dataset:
 - 2 central muons $p_T > 1.5$ GeV
 - Run I: > 2 GeV
 - Trigger on $J/\psi \rightarrow \mu\mu$ decays
- Collect ~ 70 pb^{-1}
- ~ 0.5M $J/\psi \rightarrow \mu\mu$ signals



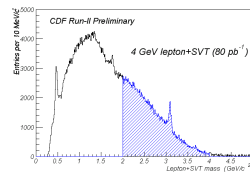
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CDF Trigger for B/Charm Physics

- (2) Lepton + Track
 - 1 muon/electron $p_T > 4$ GeV
 - 1 other track with
 - $p_T > 2$ GeV, SVT IP $> 120 \mu\text{m}$
 - $M(\ell\text{-Track}) < 5$ GeV
- Collect ~70 pb^{-1} of data
- ~ 0.5M $B \rightarrow \ell X$ signal



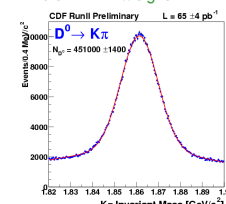
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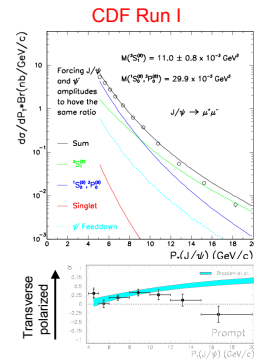
- (3) Two Track Trigger

- 2 Tracks with
- $p_T > 2$ GeV
- SVT IP $> 120 \mu\text{m}$
- $p_{T1} + p_{T2} > 5.5$ GeV
- Collect ~70 pb^{-1} of Data
- ~ 0.5M $D^0 \rightarrow K\pi$ signal



J/ψ Production Cross Section

- Run I Measurement:
 - LO calculation: $1/100 \times \text{CDF}$
- Non-relativistic QCD
 - Include color octet states
 - Theory doesn't predict the absolute normalization
 - Fitting the CDF data
- Prediction
 - J/ψ production is dominated by the color octet mechanism
 - J/ψ is polarized at high p_T
 - Some discrepancy ($\sim 2\sigma$) between the Run I polarization measurement and NRQCD
 - Awaiting Run II measurement



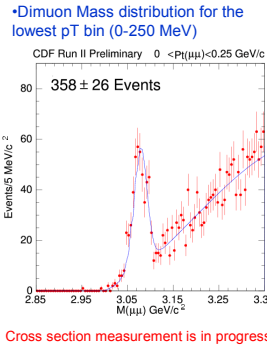
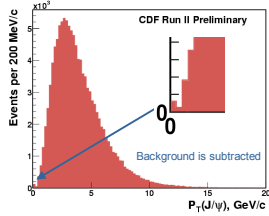
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J/ψ → μμ Cross Section

- $1.5 \times 2 = 3 < M(J/\psi) - 2M(\mu)$
 - Trigger on stopped J/ψ
- We can measure cross section down to $p_T = 0$
 - $\sigma(pp \rightarrow J/\psi; p_T > 0; |\eta| < 0.6)$
 - $\sigma(pp \rightarrow b\bar{b} \rightarrow J/\psi; p_T > 0; |\eta| < 0.6)$



Cross section measurement is in progress

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Production Cross Section: Charm

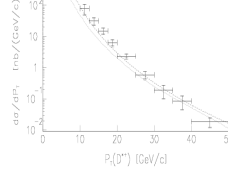
Run I Measurement:

- $D^+ \rightarrow D^0 \pi^+$; $D^0 \rightarrow \mu^+ \nu K^0$
- μ on with $p_T > 8$ GeV
- Slightly higher than theory expectation

Run II

- Use two track trigger sample
- Early Run II data (~ 6 pb $^{-1}$)
- enough statistics for counting experiment
- D^0, D^+, D^{*+}, D_s

CDF Run I (unpublished)



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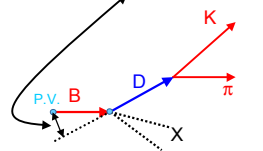
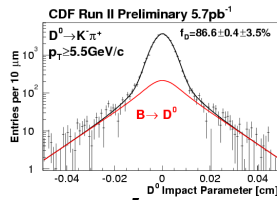
Production Cross Section: Charm

- For measuring the Charm cross section, we need to separate direct D and $B \rightarrow D$ decays
 - Use Impact parameter of D
 - D meson from B decay has larger impact parameter

Direct Charm fraction

- D^0 : $86.6 \pm 0.4 \pm 3.5\%$
- D^{*+} : $88.1 \pm 1.1 \pm 3.9\%$
- D^+ : $89.1 \pm 0.4 \pm 2.8\%$
- D_s^+ : $77.3 \pm 3.8 \pm 2.1\%$

- Cross section measurement is in progress



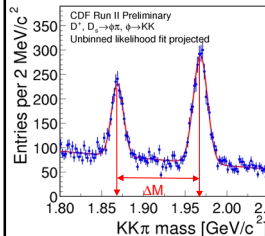
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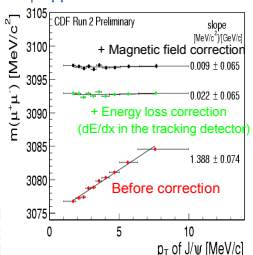
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Mass: $D_s - D^+$

- $D_s, D^+ \rightarrow \phi \pi; \phi \rightarrow KK$
 - Same final state, almost identical kinematics
 - 10 pb $^{-1}$ of two track trigger
- Measure mass difference
 - Systematics are reduced



- Momentum scale of the tracking detector is calibrated using the $J/\psi \rightarrow \mu\mu$



- Then extensively tested using $K_S \rightarrow \pi\pi, D^0 \rightarrow K\pi, \Upsilon \rightarrow \mu\mu, \dots$

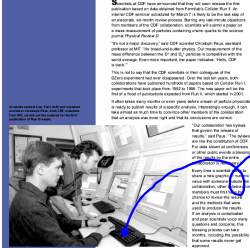
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$D_s - D^+$ Mass Difference

- It's our first Run II Paper!

CDF approves first Run II paper



It's CDF control room (We can't analyze data here!)

- Results: $M(D_s) - M(D^+)$
 - $99.41 \pm 0.38 \pm 0.21$ MeV/c 2
 - (PDG: 99.2 ± 0.5 MeV/c 2)



A typical place where CDF physics is being produced

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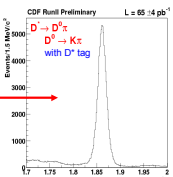
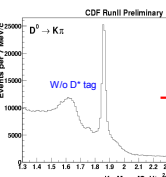
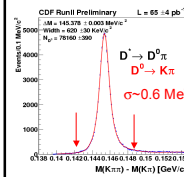
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D^* tagging

- Very high purity D^0 signal using "D* tag" technique
 - $D^{*+} \rightarrow D^0 \pi^+$; $Q = 39$ MeV
 - $M(D^*) - M(D^0)$:
 - $\sigma(M_D) \sim 10$ MeV
 - $\sigma(\Delta M) \sim 0.6$ MeV
 - 20% of the D^0 : D^{*+} tagged

- Eliminate the "reflection" background ($D^0 \rightarrow K\pi$ and πK)
- Initial flavor of D^0 is known
 - $D^{*+} \rightarrow D^0 + \pi^+ / D^{*-} \rightarrow D^0 + \pi^-$
 - The best place to study D^0 mixing and CP violation

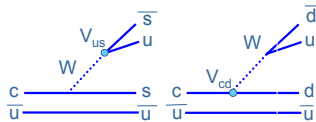


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Cabibbo Suppressed D^0 Decays



- Summer 2002 (10 pb^{-1}): no D^* tagging
 - $\text{Br}(D^0 \rightarrow KK)/\text{Br}(D^0 \rightarrow K\pi) = (11.17 \pm 0.48 \pm 0.98)\%$
 - $\text{Br}(D^0 \rightarrow \pi\pi)/\text{Br}(D^0 \rightarrow K\pi) = (3.37 \pm 0.20 \pm 0.16)\%$
 - main systematics: background subtraction

- Spring 2003 (65 pb^{-1}): with D^* tagging
 - Repeat the Br measurement
 - Direct CP asymmetry in $\pi\pi$ and KK decay
 - Results expected soon

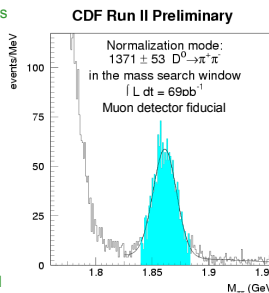


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Rare Decay Search: $D^0 \rightarrow \mu\mu$

- $D^0 \rightarrow \mu\mu$
 - SM expectation : $\sim 10^{-13}$
 - Enhancement by new physics
 - R-parity violating SUSY: $\sim 10^{-6}$
 - Current best limit
 - $< 4.1 \times 10^{-6}$ (90% CL)
 - E777, Beatrice
- Analysis
 - Use D^* tagged D^0
 - Use $D^0 \rightarrow \pi\pi$ signal for normalization mode
 - Almost identical kinematics
 - $\text{Br}(D^0 \rightarrow \pi\pi) \sim 1.5 \times 10^{-3}$
 - $300 D^0 \rightarrow \pi\pi \rightarrow \sim 1 D^0 \rightarrow \mu\mu$ signal ($\text{Br} = 4.1 \times 10^{-6}$)
 - $D^0 \rightarrow \pi\pi$ is one of the major sources of background as well



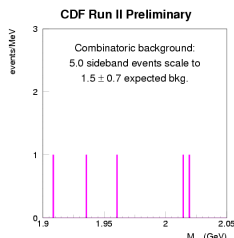
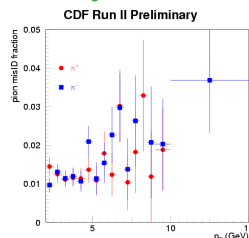
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Rare Decay Search: $D^0 \rightarrow \mu\mu$

- Background (1)
 - $D^0 \rightarrow \pi\pi$ with both $\pi \rightarrow \mu$ fake
 - $N_{bg} = N(\pi\pi) \times \text{prob}(\text{fake})^2$
 - fake prob. Is measured in $D^0 \rightarrow K\pi$ signal
- Background (2)
 - Combinatorial background
 - Linear extrapolation of the high mass sideband events



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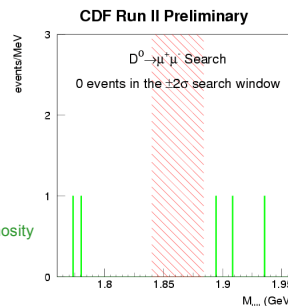
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Rare Decay Search: $D^0 \rightarrow \mu\mu$

- Expected background after the optimized selection cuts
 - 1.7 ± 0.7 events
 - Fake: 0.22 ± 0.02
 - Combinatorial: 1.5 ± 0.7
- 0 events in search window

- New best limit
 - $\text{Br} < 2.4 \times 10^{-6}$ at 90% CL
 - $\text{Br} < 3.1 \times 10^{-6}$ at 95% CL
- For future:
 - Much higher integrated luminosity
 - Need further background study
 - $D^0 \rightarrow e\mu, ee$
 - $D^+ \rightarrow \mu\mu\pi$

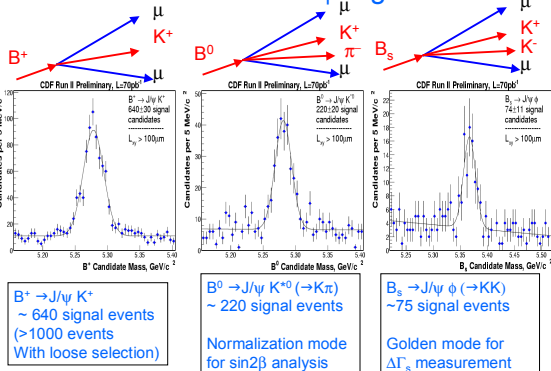


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Exclusive $B \rightarrow J/\psi$ Signals



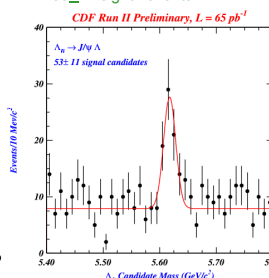
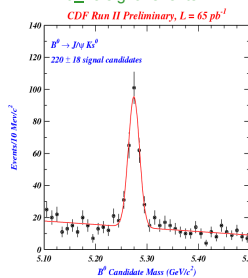
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More $B \rightarrow J/\psi$ signals

- $B^0 \rightarrow J/\psi K^0$
 - Golden mode for $\sin 2\beta$
 - 220 ± 18 signal events
- $\Lambda_b \rightarrow J/\psi \Lambda$
 - Mass and Lifetime
 - 53 ± 11 signal events



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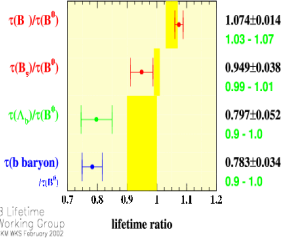
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B Lifetime

•Heavy Quark Expansion (HQE)
predicts the lifetimes for different
B hadron species

- $\tau(B_s) < \tau(\Xi_b) \sim \tau(\Lambda_b)$
- $\tau(B^0) \sim \tau(B_s) < \tau(B^-)$
- $\tau(\Xi_b) < \tau(\Lambda_b)$

- $\tau(B^+)/\tau(B^0) = 1.03 \pm 0.07$
- $\tau(B_s)/\tau(B^0) = 1.00 \pm 0.01$
- $\tau(\Lambda_b)/\tau(B^0) = 0.9 \pm 1.0$



- B^+/B^0 and B_s/B^0 measurements agree with prediction
- Small discrepancy for Λ_b lifetimes
- LEP + CDF Run I

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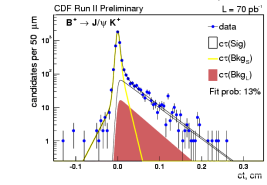
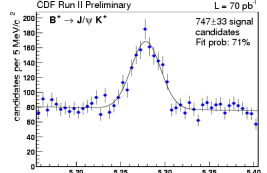
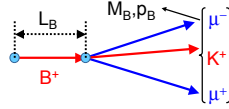
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$B^0, B^+,$ and B_s Lifetimes

•Use exclusively reconstructed B signals in $J/\psi \rightarrow \mu\mu$ dataset

- $B^+ \rightarrow J/\psi K^+$
- $B^0 \rightarrow J/\psi K^0 (K^0 \rightarrow K\pi)$
- $B_s \rightarrow J/\psi \phi (\phi \rightarrow K\bar{K})$
- $\Lambda_b \rightarrow J/\psi \Lambda (\Lambda \rightarrow p\pi)$: in progress
- $ct = L_B / \beta_B \gamma M_B^{PDG}$
- Simultaneous fitting to
- M_B : Extract signal fraction
- ct : Extract the lifetime



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B Lifetime Results

•Lifetime Results:

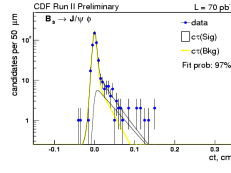
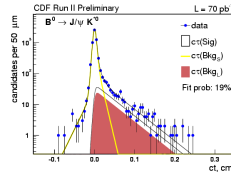
- $B^+ 1.57 \pm 0.07 \pm 0.02$ ps
- PDG: 1.674 ± 0.018 ps
- $B^0 1.42 \pm 0.07 \pm 0.02$ ps
- PDG: 1.542 ± 0.016 ps
- $B_s 1.26 \pm 0.20 \pm 0.02$ ps
- Measured lifetime depends on the mixture of two CP states
- PDG: 1.461 ± 0.057 (average)

•Lifetime Ratio results

- $B^+/B^0 1.11 \pm 0.09$
- PDG: 1.083 ± 0.017
- $B_s/B^0 0.89 \pm 0.15$
- PDG: 0.947 ± 0.038

•Prospects

- Stat. error on lifetime will be approximately scaled down by $[70 \text{ pb}^{-1} / \mathcal{L}(\text{Run2})]^{-1/2}$



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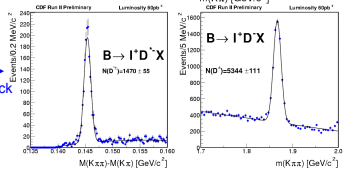
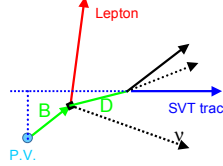
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Semileptonic $B \rightarrow \ell \nu + D^0, D^+, D^*$

•Lepton + Track dataset (60 pb^{-1})

- $B \rightarrow \ell D^0 X (D^0 \rightarrow K\pi)$: $\sim 10K$
- $B \rightarrow \ell D^{*+} X (D^{*+} \rightarrow D^0 \pi^+)$: $\sim 1.5K$
- $B \rightarrow \ell D^+ X (D^+ \rightarrow K\pi\pi)$: $\sim 5K$
- Good signals for calibration
- Measure $B^+ \rightarrow B^0$ and B^0 lifetime
- Study $B^0 \rightarrow B^+$ mixing



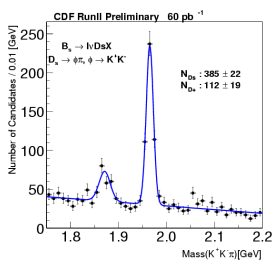
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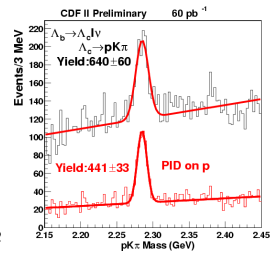
Semileptonic B_s and Λ_b Decays

• $B_s \rightarrow \ell \nu D_s X (D_s \rightarrow \phi \pi)$



Lifetime: stat. ~ 0.07 ps
(PDG: 0.057 ps)
Future: B_s mixing (low Δm_s case)

• $\Lambda_b \rightarrow \ell \nu \Lambda_c X (\Lambda_c \rightarrow p K \pi)$



Lifetime: stat. ~ 0.12 ps
(PDG: 0.08 ps)
Future: semileptonic form factor

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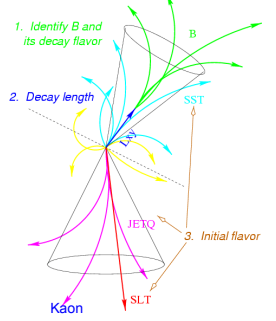
Flavor Tagging

•B flavor tagging

- For reconstructed B, to identify whether the B is generated as the b or \bar{b} (Mixing, CP violation)
- Tagging efficiency: ϵ
- Dilution: $D = 1 - 2\omega$
- Effective tagging efficiency ϵD^2
- Effective statistics: $N_{sig} \rightarrow N_{sig} \epsilon D^2$

Run II Projections in Tevatron YB

	$B^0 \rightarrow J/\psi K_s$	$B_s \rightarrow D_s \pi$
SST	1.9%	4.2% (TOF)
SLT	1.7%	1.7%
JETQ	2.0%	3.0%
Kaon	2.4%	2.4%
Total	9.0%	11.3%



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Flavor Tagging

- Statistical uncertainty for tagging efficiency

- A typical tagging: $\epsilon=0.1, D=0.4, \epsilon D^2=1.6\%$
- 1000 events: $\epsilon D^2=1.6 \pm 0.7\%$ (44%)
- 100K events: $\epsilon D^2=1.60 \pm 0.07\%$ (4.4%)

- We can't study/optimize the flavor tagging with $\sim O(1000)$ events of the B signal events

- $B \rightarrow J/\psi K$: ~ 1000 events/100pb $^{-1}$
- $B \rightarrow D\pi$: ~ 500 events/100pb $^{-1}$

- Our solution: Use Semileptonic B decays in the lepton + track dataset
- $\sim 200K$ semileptonic B signal events
- High B purity
- Lepton Charge = Decay flavor of B



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B $\rightarrow h^+h^-$

- B $\rightarrow h^+h^-$ signal in the two track trigger sample

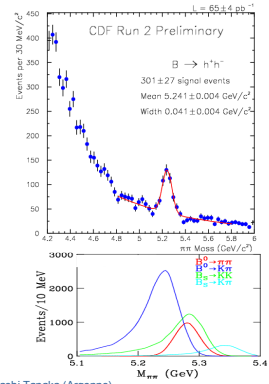
- 301 \pm 27 signal events
- Good S/N ~ 1

- This signal is combination of four decay channels

- Tree ($Br \sim 5 \times 10^{-6}$)
- $B^0 \rightarrow \pi\pi$: $B_s \rightarrow K\pi$
- Penguin ($Br \sim 1.5 \times 10^{-5}$)
- $B^0 \rightarrow K\pi$: $B_s \rightarrow KK$

- We can separate these decays

- Decay kinematics
- COT dE/dx



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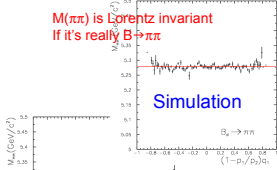
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B $\rightarrow h^+h^-$

- Kinematical Separation

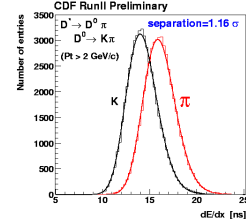
- $\alpha = (1 - p_1/p_2) q_1$
- $M(\pi\pi)$

$M(\pi\pi)$ is Lorentz invariant if it's really $B \rightarrow \pi\pi$



$M(\pi\pi)$ is not Lorentz invariant for $B \rightarrow K\pi$

- dE/dx Separation



First results expected soon

- $Br(B^0, B_s \rightarrow KK, K\pi, \pi\pi)$
- Direct CP asymmetry in $B \rightarrow K\pi$
- $\sim 15\%$ resolution for A_{CP}

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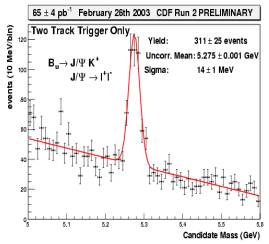
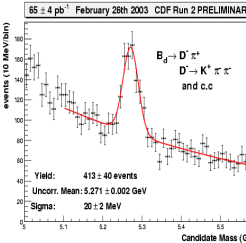
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Hadronic B signals

- Two track trigger data (65 pb $^{-1}$)

- Reconstruct hadronic B decays
- $B^0 \rightarrow D^+ \pi^-$ ($D^+ \rightarrow K\pi\pi$): 413 ± 40
- $B^+ \rightarrow J/\psi K$ ($J/\psi \rightarrow \ell\ell$): 311 ± 25



Normalization mode for the other decays

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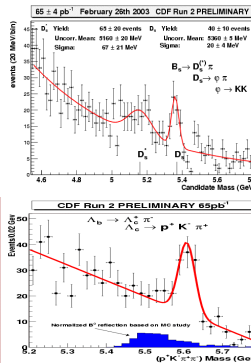
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Hadronic B $_s$ and Λ_b Decays

- $B_s \rightarrow D_s \pi$
- Golden mode for B_s mixing
- 65 pb $^{-1}$ of two track trigger data
- $B_s \rightarrow D_s \pi$ ($D_s \rightarrow \phi \pi$): 40 ± 10 events
- $B_s \rightarrow D_s^* \pi$ ($D_s^* \rightarrow \phi \pi$): 65 ± 20 events
- More channels to be added
- $B_s \rightarrow D_s \pi \pi \pi$
- $D_s \rightarrow K^* K, K^0 K, \pi \pi \pi$
- Further optimization of trigger strategy to obtain more signals
- Estimate the sensitivity for B_s mixing
- Flavor tagging, time resolution...

- $\Lambda_b \rightarrow \Lambda_c \pi$ ($\Lambda_c \rightarrow p K \pi$)
- ~ 40 events in 65 pb $^{-1}$
- More channels to be added
- $\Lambda_b \rightarrow \Lambda_c \pi \pi \pi, p D^0 \pi$
- $\Lambda_c \rightarrow \Lambda \pi \pi \pi$



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Summary

- Run II CDF collected ~ 100 pb $^{-1}$ of data
- ~ 85 pb $^{-1}$ for Jet physics, ~ 70 pb $^{-1}$ for B/Charm physics
- Many Interesting physics studies are being made
- 1.8 TeV \rightarrow 1.96 TeV: x5 higher Jet cross section at $E_T = 600$ GeV
- New detector and trigger system:
 - Forward detectors \rightarrow Diffractive physics
 - The SVT \rightarrow Great success!
 - CDF as Charm/B factory
 - Unique at hadron collider
- We are working hard to understand the new detector and trigger systems
- Some of the systematic uncertainties are still large (conservative)
- They can be reduced in future
- We are preparing for high luminosity
- QCD: B jet cross section, W+Jet cross section,...
- Charm: D^0 mixing, CP asymmetry, rare decays...
- Bottom: studies of B_s, Λ_b, B_c , CP violation, B_s mixing...

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